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THE ANNALS
AND
MAGAZINE OF NATURAL HISTORY.

INCLUDING

ZOOLOGY, BOTANY, AND GEOLOGY.

(BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH LOUDON AND CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY.')

CONDUCTED BY

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Megachile femorata, Smith.

Smith's ♂ type has a large yellowish (suffused marginally with red) area on mandibles. Male *M. latimanus*, Say, in the Museum (New York, *H. Edwards*), has the same sort of mid-tarsi as *femorata*; the eyes are green, whereas in *femorata* they are suffused with pale red. The keel of sixth segment in *latimanus* has a deep U-shaped emargination; in *femorata* the emargination has the form of a very wide V, the sides of which are irregular.

XXVIII.—A Preliminary Synopsis of the Asteriidæ, a Family of Sea-Stars*. By W. K. FISHER, Director, Hopkins Marine Station, California.

THE present synopsis is not a thoroughgoing revision of the Asteriidæ, available material being insufficient for such an attempt. It may more properly be considered an "account of stock." Of recent years the number of genera of Asteriidæ has greatly increased, owing to the discovery of new types and to a more careful scrutiny of the forms included within the traditional *Asterias*, *Coscinasterias*, and *Stichaster*. In certain sections of the Asteriidæ the genera present a confusing similarity of outward appearance, which recalls free crinoids.

The larger subheads of the synopsis occasionally associate genera not closely related, but this defect renders the key of greater practical value. Free use has been made of characters not heretofore employed, and certain genera, such as *Orthasterias* and *Coscinasterias*, have been dismembered. Discussion of numerous changes has been deferred owing to exigencies of space.

The key will be found of little value for immature stages. These cannot be identified in most instances without accompanying adult specimens, as young are usually too generalized to show their generic characters.

I have not been able to find satisfactory features by which

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to separate the Pedicellasteridæ from the Asteroiidæ. Like most asteroid groups, they run together. *Pedicellaster*, *Hydrasterias*, *Anteliaster*, and *Peranaster* are extremes in which there is no adoral carina (*i. e.*, the adambulacral plates do not join interradially behind the mouth-plates as in the Asteroiidæ). But *Tarsaster*, Sladen, and *Ampheraster*, Fisher (type, *Sporasterias mariana*, Ludwig), are in some respects intermediate, though they are nearer to *Pedicellaster* than to *Asterias*.

The Heliasteridæ can conveniently be kept separate from the Asteroiidæ on the basis of the peculiar structure of the internal skeleton. There is an oblique or horizontal circular shelf which extends from the actinostomial skeleton obliquely upward to the abactinal wall and separates the cœlom of disk from that of ray save for a small passage near the abactinal wall. Ventrally the cœlom of ray ends in a shallow cul-de-sac near the inner end of the ambulacral ridge, where in the Asteroiidæ the cœlom of disk communicates with that of ray. Viguier reports the odontophore as consisting of two plates, which is not true of the Asteroiidæ.

Genera of the Asteroiidæ are now sufficiently numerous to render subfamilies useful. It is well to regard these groups as convenient sections in which to arrange genera of ascertained relationship rather than as units definitely segregated one from another. The Coscinasterinæ is one of the best-marked and most easily recognized. I think all the subfamilies are natural, except the Asteroiidæ, which may be resolved into the following sections in accordance with the lettered groups of genera:—(a) Asteroiidæ, (b) Pisasterinæ, (c) Stichasterinæ, (d) Podasteriidæ, (e) Aphelasteriidæ, (f) incertæ sedis. Of these, group a is sharply marked from the rest by the actual or potential presence of pedicellariæ on the adambulacral spines, though they are absent as an individual and varietal variation in some forms of *Leptasterias*. It is very questionable if such a refinement as the above is at present needed, so that the Asteroiidæ in the following synopsis may be considered a sort of residuary legatee. The Pycnopodiinæ is possibly a specialized relative of the Coscinasteriidæ.

The following genera do not occur in the key, except as synonyms:—

- Allasterias*, Verrill (*Asterias*).
- Anasterias*, auct. (*Lysasterias*).
- Asteroderma*, Perrier (*Lysasterias*).
- Calycaster*, Perrier (*Neomorphaster*).
- Cœlasterias*, Verrill (*Stichaster*).

- Ctenasterias*, Verrill (*Leptasterias*).
Diplasterias, Perrier (*Cosmasterias*).
Hemiasterias, Verrill (*Granaster*).
Heterasterias, Verrill (*Coronaster*).
Labidiastrella, Verrill (*Labidiaster*).
Margaraster, Gray.
Nanaster, Perrier (*Stephanasterias*).
Parasterias, Verrill (*Asterias*).
Parastichaster, Koehler (*Sporasterias*).
Pædasterias, Verrill (*Lysasterias*).
Polyasterias, Perrier (*Coscinasterias*).
Quadraster, Perrier (*Cosmasterias*).
Stichorella, Koehler (*Calvasterias*).
Tonia, Gray (*Stichaster*).

I. Synopsis of Subfamilies of Asteroiidae.

- a*¹. No adoral carina—the first pair of postoral adambulacral plates separated interradially or in contact only along the adoral part of interradiial margin; tube-feet biserial, or quadriserial on proximal part of ray.
1. PEDICELLASTERINÆ, Fisher. Rays 5 to 8; skeleton an open network composed of mostly small cruciform or trilobate plates; spinelets small; never more than one prominent inferomarginal spine (except in questionable *Lytaster*); crossed pedicellariæ scattered, never in circlets about spinelets; straight pedicellariæ present; no adambulacral spine pedicellariæ.
Pedicellaster, Sars, *Hydrasterias*, Sladen, *Peranaster*, gen. nov., *Anteliaster*, gen. nov., *Ampheraster*, gen. nov., *Tarsaster*, Sladen, *Lytaster*, Perrier?
 - a*². An adoral carina—one, usually several, pairs of postoral adambulacral plates in contact by interradiial margins; tube-feet quadriserial, at least proximally.
 - b*¹. Adambulacral spines without attached pedicellariæ, singly or in clusters.
 2. LABIDIASTERINÆ, Verrill. Rays numerous, long, slender, in combination with only 1 inferomarginal spine carrying a wreath of crossed pedicellariæ; abactinal skeleton either very open with large squarish meshes or else abortive with scattered independent plates; crossed pedicellariæ in abactinal spinal wreaths or thick ruffs; no actinal plates.
Labidiaster, Lütken, *Coronaster*, Perrier, *Rathbunaster*, Fisher.
 3. NOTASTERIINÆ, subfam. nov. Rays 5; with peculiar macrocephalous crossed pedicellariæ; carinal and marginal plates prominent, with prominent spine (inferomarginals in one case with 2); dorsolateral skeleton reticulate, often very weak, the spines poorly developed and without proper wreaths of pedicellariæ; no actinal plates.
Notasterias, Koehler, *Autasterias*, Koehler, *Urasterias*, Verrill, *Icasterias*, gen. nov.
 4. COSCINASTERIINÆ, subfam. nov. Abactinal skeleton well developed, with carinals and often dorsolaterals in definite series. Rays 5 to

many, with prominent, wreathed, spaced, styliform or acicular spines, often in evident longiseries, in combination with: regularly 2 inferomarginal spines, gonads opening dorsally, actinal plates in not more than 1 series, and adambulacral spines entirely devoid of attached pedicellariæ.

Stylasterias, Verrill, *Eustolasterias*, gen. nov., *Astrometis*, gen. nov., *Sclerasterias*, Perrier, *Coscinasterias*, Verrill, *Astrostole*, gen. nov., *Distolasterias*, Perrier, *Lethasterias*, gen. nov., *Marthasterias*, Jullien, *Meyenaster*, Verrill, *Australiaster*, gen. nov., *Orthasterias*, Verrill.

5. PYCNOPODIINÆ, Verrill. Abactinal skeleton abortive, composed of isolated plates and tongues of ossicles bearing wreathed acicular spines; no actinal plates; rays 5 to many. Otherwise as in 4.

Pycnopodia, Stimpson, *Lysastrostoma*, Fisher.

6. NEOMORPHASTERINÆ, subfam. nov. Primary apical plates conspicuously enlarged; abactinal and marginal plates subhexagonal, closely imbricated in 7 regular longiseries (resembling *Zoroaster*), sparsely granulated; actinal plates with short spinelets.

Neomorphaster, Sladen.

*b*². Adambulacral spines carry pedicellariæ singly or in clusters, or are entirely without attached pedicellariæ.

7. ASTERINÆ, Verrill. Abactinal spines not as a rule prominent, styliform or acicular and more or less spaced and isolated, but short, slender to stout, conical, tubercular-subglobose, variously granuliform, sharp to capitate, single or in groups; abactinal plates in more or less definite longiseries or irregularly reticulate, sometimes abortive; actinal area sometimes broad, with upwards of 5 longiseries of plates, sometimes without any actinal plates; gonads opening dorsally, laterally, or ventrally.

- (1) Adambulacral spines with pedicellariæ.

(a) *Asterias*, Linn., *Evasterias*, Verrill, *Leptasterias*, Verrill, *Stenasterias*, Verrill.

- (2) Adambulacral spines entirely without pedicellariæ.

(b) *Pisaster*, M. & T., *Uniophora*, Gray.

(c) *Cosmasterias*, Sladen, *Stichaster*, M. & T., *Allostichaster* Verrill, *Calvasterias*, Perrier, *Stichastrella*, Verrill.

(d) *Podasterias*, Perrier, *Cryptasterias*, Verrill, *Sporasterias*, Perrier, *Lysasterias*, Fisher, *Koehleraster*, Fisher, *Adelasterias*, Verrill.

(e) *Aphelasterias*, gen. nov., *Aphanasterias*, gen. nov. *Stephanasterias*, Verrill, *Smilasterias*, Sladen.

(f) *Granaster*, Perrier, *Gastraster*, Perrier, *Tarsastrocles*, gen. nov., *Saliasterias*, Koehler.

II. Synopsis of the Genera of Pedicellasterinæ and Labidiasterinæ.

- a*¹. Rays 5 or 6; not fissiparous.

*b*¹. Inferomarginal spines not conspicuously larger than the supermarginals, nor forming a prominent longiseries external to the adambulacral spines; the latter are the longest on ray, in

transverse combs of 2 to 5; no quartette of enlarged or especially strong plates in each interbrachium; tube-feet biserial; first post-oral pair of adambulacral plates widely separated interradially.

*c*¹. Actinal plates absent, the inferomarginals juxtaposed to the adambulacrals; inferomarginal spinelets small; crossed pedicellariæ all of one kind, small, with numerous small, uniform, terminal teeth; gonads opening on extreme edge of abactinal area. Type, *Asterias ophidion*, Sladen

[Sladen*.
Hydrasterias,

*c*². Actinal plates present; crossed pedicellariæ with one or more enlarged teeth on the distal portion of the jaw.

*d*¹. Straight pedicellariæ not unusually large nor spatulate-unguiculate; gonads opening ventrally; actinal plates of large specimens in closely imbricated transverse series, the number of plates per series (in some species) increasing on middle third of ray instead of decreasing; *crossed pedicellariæ of two sorts*, the larger with slenderer jaws and 4 large claw-like terminal teeth and 1 to 4 conspicuous teeth on the shank, below the terminal; the smaller (abactinal) pedicellariæ have numerous small terminal teeth, none conspicuously enlarged. Type, *Pedicellaster typicus*, Sars

[Sars†.
Pedicellaster,

*d*². With very large spatulate-unguiculate straight pedicellariæ; gonads opening dorsally; actinal plates in [2] simple longiseries; crossed pedicellariæ, not

* *Hydrasterias ophidion* is closely related to, possibly the same as, *Pedicellaster sexradiatus*, Perrier. The genus includes also *Pedicellaster improvisus*, Ludwig, eastern Pacific, off Cocos and the Galapagos. Dr. R. Kirkpatrick, of the British Museum, examined the oral angle of *Hydrasterias ophidion* and *Tarsaster stoichodes*, sent pedicellariæ and enlarged photographs of each species. This courtesy has enabled me to "identify" these genera, long misunderstood. The various species of *Hydrasterias* described since Sladen's time belong to other genera—*Eustolasterias* and *Tarsastrocles* principally.

† The generic diagnosis is not based upon the depauperate North Atlantic *typicus* so much as upon large congeneric species such as *P. formatus*, Koehler, *P. antarcticus*, Ludwig, and especially upon *P. magister*, sp. n., from 'Albatross' station 4792, 72 fathoms, off Bering Island, Bering Sea, which differs from *P. typicus* in regularly attaining a gigantic size ($R=85$ mm., $r=12$ mm.). It has an extensive dorsolateral region and a conspicuous actinal area, crossed by transverse series of imbricating four-lobed plates which increase in number per series toward middle third of the ray, and decrease slowly in the final third. The larger of the two sorts of crossed pedicellariæ are larger, slenderer, and have longer terminal claws and only 2 or 3 long slender shank-teeth. *P. pourtalesi* belongs to this genus.

- obviously of two different sorts, have 1 or 2 enlarged lateral terminal teeth and numerous small ones. Type, *Pedicellaster chirophorus*, Fisher (Celebes) [gen. nov.*.
Peranaster,
- c*³. Actinal plates present; crossed pedicellariæ with the numerous terminal teeth uniformly tiny; gonads opening ventrally; actinal plates in 1 or 2 longiseries; prominent, unguiculate, straight pedicellariæ in some species. Type, *Anteliaster coscinactis*, sp. n. [gen. nov.†.
Anteliaster,
- b*². External to the adambulacral spines is a longitudinal series of prominent inferomarginal spines conspicuously larger than the superomarginals (which are subequal to the abactinal spinelets); no actinal plates; a quartette of strong interbrachial marginal plates; first pair of postoral adambulacral plates narrowly separated or touching by adoral corners.
- c*¹. Straight pedicellariæ not unguiculate, not broadly spatulate; an accessory inferomarginal spinelet above the major spine (at least proximally); adambulacral plates diplacanthid or diplacanthid and monacanthid; interbrachial marginals not much enlarged; superomarginals regularly four-lobed (not warped or irregular nor three-lobed). Type, *Tarsaster stoichodes*, Sladen. [Sladen †.
Tarsaster,
- c*². Straight pedicellariæ unguiculate, often also strongly spatulate; no accessory inferomarginal spinelet or tubercle; adambulacral plates predominantly monacanthid (a few plates may be diplacanthid); 2 enlarged interbrachial superomarginals over-

* *Περαν*, signifying "on the other side, across," in allusion to the remote habitat of this type-species with reference to its nearest allies—figuratively, with reference to its characters in relation to *Pedicellaster*.

† *Αντηλιος*, eastern, *i. e.*, the eastern Pacific. The type-species is *Anteliaster coscinactis*, sp. n., 'Albatross' station 4427, south-west of Point San Pedro, Santa Cruz Island, California, 447 to 510 fathoms, black mud, rocks. Rays 5, long, slender, flexible, very gradually tapered to a bluntly pointed extremity; disk small; body-wall thin; spinelets very small, close-set, alternating, on the rather large-meshed skeleton, with small crossed pedicellariæ; abactinal papular areas irregular (in equivalent of about three longiseries); 3 actinolateral regular series of subquadrate meshes (1 intermarginal and 2 actinal); 2 series of slender actinal plates; adambulacral spinelets longer than any of the others, proximally 4 or 3, then 2, in transverse combs; large hand-shaped unguiculate straight pedicellariæ. $R=63$ mm., $r=9$ mm., $R=7r$.

‡ *Tarsaster*, pedicellariæ and enlarged photographs of the type of which I have examined (see footnote on *Hydrasterias*), includes *Sporasterias cocosana*, Ludwig, and *S. galapagensis*, Ludwig, as well as *Asterias fascicularis*, Perrier (*Leptasterias fascicularis*, Verrill), off Guadeloupe, West Indies, 309 fathoms. I have examined specimens of all three species.

- lap 2 corresponding, sometimes enlarged inferomarginals; superomarginals often three-lobed or irregularly four-lobed (proximal plates generally fairly regular). Type, *Sporasterias mariana*, Ludwig [gen. nov.*.
Ampheraster,
- a*². Rays 3 to 8, fissiparous; adambulacrals monacanthid; a vertical comb of 3 inferomarginal spines; between inferomarginals of two sides of ray are 5 longiseries of + -form plates bearing on ray 1, on disk 1 to 3 spinelets; tube-feet biserial; crossed and small straight pedicellariæ. (This genus is founded upon obviously young specimens, and may belong elsewhere.) Type, *Lytaster æqualis*, Perrier *Lytaster*, Perrier.
- a*³. Rays 9 to 45; a single prominent inferomarginal spine enveloped in a sheath (carrying on the usually expanded distal surface a conspicuous wreath of pedicellariæ).
- b*¹. Abactinal skeleton reduced to isolated plates bearing slender acicular spines (with a thick distally expanded sheath, bearing large crossed pedicellariæ with numerous shank-teeth and enlarged lateral terminal teeth); alternate superomarginal plates and spines abortive; straight pedicellariæ not spatulate unguiculate; rays 12 to 20, very flexible. Type, *Rathbunaster californicus*, Fisher [Fisher.
Rathbunaster,
- b*². Abactinal skeleton with large squarish meshes; alternate superomarginals not suppressed.
- c*¹. Rays 9 to 11; abactinal and marginal spines acicular, prominent, solitary, rather widely spaced; skeleton of outer part of ray not reduced to transverse bands of plates carrying cushions of pedicellariæ; straight pedicellariæ large, spatulate, unguiculate. (Includes *Heterasterias*, Verrill.) Type, *Coronaster parfaiti*, Perrier [Perrier.
Coronaster,
- c*². Rays 5 to 25; marginal and abactinal spinelets not very prominent nor widely spaced, more or less aggregated in transverse bands; skeleton of outer part of ray reduced more or less to transverse arches carrying cushions of pedicellariæ; straight pedicellariæ not large, unguiculate. (Includes *Labidiastrella*, Verrill.) Type, *Labidiaster radiosus*, Lütken [Lütken.
Labidiaster,

* *Ἀμφηρης*, signifying "having oars on both sides," in allusion to the inferomarginal spines which stand out on either side of the ray, suggesting a bank of oars. The following are the species:—*Ampheraster marianus* (Ludwig); *A. hyperoncus* (Clark), as *Pedicellaster*; *A. distichopus* (Fisher), as *Tarsaster*.

III. *Synopsis of the Genera of the Asteroiidae (except Pedicellasterinae and Labidiasterinae).*

1. The carinal, the conspicuous marginal, and the actinal plates (when present) form regular longiseries; carinals, dorsolaterals (sometimes also in regular longiseries), and superomarginals carry a single stout or slender, smooth or fluted, sharp or blunt, prominent, spike-like spine (sporadically 2 or 3), provided with a collar of crossed pedicellariæ; inferomarginals regularly with 2 prominent spines (sporadically 3); actinal plates never in more than one series, sometimes lacking; adambulacral spines 1 or 2, always without attached pedicellariæ (but these may occur on oral spines); gonads, so far as known, open dorsally; species not pædophoric; (special macrocephalous type of crossed pedicellariæ not present).
 - a*¹. Only the outer of the two inferomarginal spines carries a cluster of crossed pedicellariæ.
 - b*¹. Adambulacral plates diplacanthid, at least on proximal half of ray; as a rule only 2, or equivalent of 2, series of dorsolateral papular areas (by no means always regular) on either side of the carinal plates. (Alternate superomarginals usually spineless.)
 - c*¹. Rays regularly only 5 in adults, but 6 in fissiparous young of some forms.
 - d*¹. Size medium or large; skin not unusually thick; intermarginal and usually also actinal papulæ; at least 2 longiseries of dorsolateral papulæ.
 - e*¹. Large spatulate, denticulate, straight pedicellariæ; outer inferomarginal spines without trace of a ventrolateral web; rays semicircular or heptagonal in section; dorsolateral skeleton very irregular, the skeletal meshes not in two regular series on either side of the carinal ridge; dorsolateral spines developed in even tiny specimens; they are numerous, in one or two irregular series on each side; adambulacral plates diplacanthid proximally, monacanthid distally. Type, *Asterias sertulifera*, Xantus [gen. nov.*. *Astrometis*,
 - e*². Straight pedicellariæ, slender, lanceolate; outer inferomarginal spines connected in longiseries by a continuous more or less fibrous web confined to base of spines and sometimes much retracted in dried specimens; rays penta-

* *Orthasterias gonolena*, Verrill, "off Southern California," is a synonym of *Astrometis sertulifera*. *Orthasterias californica*, Verrill, off San Francisco, and *O. dawsoni*, Verrill, Queen Charlotte Islands, belong to this genus, but are probably only subspecies of *sertulifera*. I have examined the types of both, as well as that of *sertulifera*, which is from Cape San Lucas, Lower California.

gonal in section; dorsolateral skeleton regular, with two series of skeletal meshes on either side of the prominent carinal ridge; dorsolateral spines usually late in developing and in only one series; adambulacral plates diplacanthid throughout; the very young are fissiparous, usually six-rayed, possibly reproducing regularly by fission.

Type, *Coscinasterias euplecta*, Fisher.

[gen. nov.*.
Eustolasterias,

*d*². Size very small; plates arranged essentially as in young *Eustolasterias*, but covered by a thick skin, marked by strong transverse furrows between consecutive arcs of plates; adambulacral plates diplacanthid; no intermarginal or actinal papulae; one dorsolateral series of large isolated papulae on either side of the carinals; (plates of ray above the adambulacrals form seven very regular longiseries, and also regular transverse arcs; inferomarginals with an oblique series of two spines; above these five longiseries of small obtuse spines encircled by a collar of crossed pedicellariae; dorsal straight pedicellariae).

Type, *S. guernei*, Perrier

[Perrier.
Sclerasterias,

*c*². Rays 7 to 9; so far as known not fissiparous; in general appearance similar to *Eustolasterias*, but ray less markedly hexagonal in section; a well-developed series of dorsolateral and actinal spines; inferomarginal web absent or very rudimentary; only alternate superomarginals spiniferous, the plates generally with a conspicuous beaded area; mouth-angle rather narrow, with three to five contiguous pairs of postoral adambulacral plates; straight pedicellariae medium to large, smooth or denticulate.

Type, *Margaraster scaber*, Hutton

[gen. nov.†.
Astrostole,

*b*². Adambulacral plates monacanthid throughout ray.

*c*¹. One series of spiniferous actinal plates.

* This genus includes also *Distolasterias hypacantha*, Fisher, *Stolasterias alexandri*, Ludwig, *Asterias angulosa*, Perrier (*Orthasterias subangulosa*, Verrill), *Asterias contorta*, Perrier, *Stolasterias neglecta*, Perrier, *Asterias tanneri*, Verrill, *Asterias mollis*, Hutton.

† Includes also *Asterias rodolphi*, Perrier, *Coscinasterias platei*, Meissner, and *Stylasterias paschæ*, Clark. I have examined a specimen of *Astrostole rodolphi* from Sunday Island, Kermadecs, several *Astrostole scaber* from Wellington, New Zealand, and the type of *Astrostole paschæ* from Easter Island. The last may be the same as *Astrostole platei* (Juan Fernandez), while *Polyasterias fernandensis*, Meissner (Juan Fernandez), is not improbably young *platei*. See Archiv. f. Naturges. 1896, pp. 103, 104, pl. vi. figs. 1, 2.

- d*¹. Fissiparous, rays 7 to 12; skin covering skeleton not unusually thick and tough. (Crossed pedicellariæ larger, more tapered in profile; large straight pedicellariæ with denticulate jaws.) Type, *C. muricata*, Verrill. [Verrill. *Coscinasterias*,
- e*¹. Alternate carinal plates oblong-elliptical, without lateral lobes; mouth-angle very constricted, with five or six contiguous pairs of adambulacral plates behind the mouth-plates. Type, *C. muricata*, Verrill = *A. calamaria*, Lam. [asterias, s. s.*. Subgen. *Coscin-*
- e*². All carinal plates four-lobed; mouth-angle broader, with two or three contiguous pairs of adambulacral plates behind mouth-plates. Type, *A. tenuispina*, Lam. [asterias, Sladen †. Subgen. *Stol-*
- d*². Not fissiparous, rays 5 to 7; skeleton obscured by a thick tough skin; crossed pedicellariæ very small, round-tipped, not conspicuously tapered. (One series of spiniferous actinal plates; dorsolateral skeleton irregularly reticulated, the papular areas equivalent to three or four longitudinal series, but only the lateralmost in a regular series; abundant, large, broadly lanceolate, straight pedicellariæ, with rather compressed denticulate jaws; perhaps a subgenus of *Marthasterias*.) Type, *Asterias gelatinosa*, Meyen [Verrill. *Meyenaster*,
- e*². One series of small spineless actinal plates hidden by skin. Not fissiparous; rays 5; dorsolateral skeleton normally fairly regular, the papular areas in two longiseries on either side of the carinal series; dorsolateral and carinal spines either regular or very irregular (*africana*). Type, *Marthasterias foliacea*, Jullien = *Asterias glacialis*, Linn. [Jullien. *Marthasterias*,
- a*². The inner as well as the outer inferomarginal spine carries a cluster of crossed pedicellariæ; adambulacral plates diplacanthid.
- b*¹. Secondary oblong ossicles between consecutive plates of both carinal and superomarginal series; crossed pedicellariæ unusually large. All primary plates spiniferous; one or two series of four- or five-lobed dorsolateral plates in quincunx and connected by one or more slender ossicles, forming a very open-meshed skeleton with large, triangular, and lozenge-

* Includes two distinct species, one of which is the type. The other may be *C. gemmifera* (Perrier).

† *Polyasterias*, Perrier, is a synonym. *Asterias acutispina*, Stimpson, is typical of this group.

shaped papular areas; crossed pedicellariæ characteristically large, with clawed tips; a few relatively huge, unguiculate, straight pedicellariæ; actinal plates rudimentary, spineless; adambulacral spines 2; mouth-angle stout, with two pairs of contiguous postoral adambulacral plates; not fissiparous when adult. Type, *A. forreri*, de Loriol . . .

[Verrill,
Stylasterias,

*b*². Carinals and superomarginals directly imbricated in series, without interpolated secondary oblong ossicles; three (or the equivalent of three) or more dorsolateral series (often very irregular) of papular areas on either side of the carinal plates.

*c*¹. A definite series of well-developed actinal spines each with a conspicuous cluster of crossed pedicellariæ on its outer side; crossed pedicellariæ without two terminal teeth larger than other teeth; straight pedicellariæ large, broadly lanceolate, compressed, to spatulate denticulate or unguiculate; oral carina narrow, with upward of five contiguous pairs of postoral adambulacral plates; actinostome sunken. Type, *O. columbiana*, Verrill = *Asterias koehleri*, de Loriol

[Verrill *
Orthasterias

*c*². Actinal spines absent, or, if present, are devoid of attached pedicellariæ; adoral carina not especially long or narrow, nor actinostome sunken (two or three pairs of contiguous postoral adambulacral plates).

*d*¹. A definite series of spineless actinal plates hidden under a thick integument; each carinal and superomarginal plate regularly spiniferous.

*e*¹. Crossed pedicellariæ with two enlarged terminal teeth on each jaw, conspicuously larger than the median terminal teeth; predominant straight pedicellariæ small, slender, lanceolate (a rather slender, large, unguiculate pedicellaria occurs very rarely as a "sport," and, when present, only one or two to a specimen); dorsolateral

* Of the species described and listed by Verrill (1914, p. 168) under this genus only *columbiana*, *biordinata*, and *koehleri* (all one species) appertain to the group as defined on the basis of its type. Verrill's subgenus *Stylasterias* I hold a very distinct group. His *Orthasterias forreri*, *O. forreri forcipulata*, and *O. leptolenu* (under this subgenus) appear to me to be all one species. His *Orthasterias (Stylasterias) gonolena* (l. c. p. 184), as well as *O. californica* and *O. dawsoni* are not closely related to *Orthasterias*, s. s., but are a new generic type, *Astrometis*, Fisher (see *antea*). *Orthasterias merriami*, Verrill (l. c. p. 177), has the peculiar anatomical features of *Leptasterias*, and is close to, possibly the same as, *L. coei*, Verrill.

- plates not exceptionally numerous, in two or three regular or irregular series on each side. Type, *Asterias* (*Stolasterias*) *stichantha*, Sladen [Sladen*.
Distolasterias,
- e*². Crossed pedicellariæ without enlarged terminal teeth; predominant straight pedicellariæ relatively very large, broadly spatulate, with long curved tines (resembling a pair of clasped hands); dorsolateral plates very numerous, small, crowded, irregularly arranged, but in the equivalent of four to six (or more) series on each side; (spines ornately fluted). Type, *Distolasterias chelifera*, Verrill = *Asterias nanimensis*, Verrill [gen. nov.†.
Lethasterias,
- d*². A conspicuous series of actinal spines (without a cluster of attached crossed pedicellariæ); crossed pedicellariæ very small, without any of the terminal teeth enlarged; all straight pedicellariæ slender, lanceolate; two pairs of contiguous postoral adambulacral plates; each carinal and superomarginal not regularly spiniferous, usually only the alternate plates; dorsolateral spines few, scattered. Type, *Coscinasterias dubia*, Clark (Tasmania) [gen. nov.
Australiaster,
2. Marginal and abactinal spines conspicuous, not more than one to a plate, in long series, and devoid of a sheath carrying a collar of crossed pedicellariæ; giant crossed pedicellariæ of a peculiar type, with hooked terminally crossed jaws (*macrocephalous*, Koehler) in addition to ordinary crossed pedicellariæ and straight pedicellariæ (of two or three sorts); dorsal skeleton consisting of large, cruciform, spiniferous carinals (alternating sometimes with secondary smaller plates), to which transverse dorsolateral arcs of plates connect the superomarginals; primary spiniferous dorsolaterals poorly developed; marginals large, cruciform; one series of actinals; adambulacral spines without attached pedicellariæ.
- a*¹. Adambulacral plates diplacanthid proximally and monacanthid distally or diplacanthid throughout. Type, *N. armata*, Koehler [Koehler.
Notasterias,
- a*². Adambulacral plates monacanthid throughout. Type, *A. pedicellaris*, Koehler [Koehler.
Autasterias,

[To be continued.]

* Includes also *Stolasterias robusta*, Ludwig, Galapagos Islands.

† This group seems to be most nearly related to *Distolasterias*, of which some may prefer to regard it a subgenus. It is, indeed, unfortunate that the type-species is the same as *Asterias nanimensis*, of which I have carefully examined the type-specimen. I have also examined the type and many specimens of *chelifera*. The type of the genus is, therefore, *Distolasterias nanimensis* (Verrill) or *Lethasterias nanimensis*.

LXII.—A Preliminary Synopsis of the Asteroiidae, a Family of Sea-Stars*. By W. K. FISHER, Director, Hopkins Marine Station, California.

[Concluded from p. 258.]

3. Plates of the abactinal surface of ray have the appearance of forming rather definite longitudinal series, even when the dorsolaterals are not in regular series (in this case the dorsolateral region is narrow and dominated by the broad carinals and superomarginals); abactinal plates generally with several spinelets or granules, but, if with only one spine, then this is small and not conspicuous.
- a*¹. Adambulacral spines never carry pedicellariæ singly or in clusters, although straight pedicellariæ may occur on oral spines and on furrow-margin of adambulacral plates.
- b*¹. Adambulacrals diplacanthid.
- c*¹. Actinal plates in 1 series (or with rudiment of second) dominated by the inferomarginals which form the ventrolateral margin of ray; no large unguiculate straight pedicellariæ; crossed pedicellariæ scattered, not in clusters or wreaths around abactinal spines.
- d*¹. Primary apical plates of disk not enlarged; superomarginals conspicuously broader than inferomarginals.
- e*¹. Carinals and superomarginals of exaggerated width in proportion to length; dorsolateral area broad, the plates in 3 to 5 series on each side of the carinals; one madreporic body; not fissiparous; superomarginal plates without beaded area on surface; (gonoducts open dorsally, those of male with a proximal swelling; interbrachial septa heavily calcified. Includes *Cœlasterias australis*, Verrill, 11 rays).
Type, *S. striatus*, M. & T. *Stichaster*, M. & T.
- e*². Carinals and superomarginals broader than other plates, but not excessively so; dorsolateral area narrow, the plates in a single straight or zigzag series (altogether 3 series of abactinal plates); fissiparous; multiple madreporic bodies; superomarginal plates with beaded surface. Type, *Stichaster polyplax*, M. & T. Verrill †.
Allostichaster,
- e*³. Young *Podasterias* may lead here; see under section 4.

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† Includes *Allostichaster insignis* (Farquhar).

- d*². Primary apical plates conspicuously enlarged, occupying all of slightly sunken central portion of disk; superomarginals not conspicuously broader than inferomarginals; abactinals and marginals sparsely granulated, subhexagonal, imbricated in 7 very regular series; actinal plates with short spinelets, a second series present at base of ray only. Resembling, abactinally, a short-rayed *Zoroaster*. Type, *N. eustichus*, Sladen = *N. talismani* (Perrier) [Sladen*.
Neomorphaster,
- c*². No actinal plates; superomarginals not conspicuously broader than inferomarginals; abactinal plates rather closely imbricated in 5 definite longitudinal series; papular areas small; inferomarginals with a transverse oblique comb of flattened spines; abactinal plates with a group of 5 or 6 small spinelets; plates very regular; tube-feet quadriserial proximally. Founded upon one very small specimen (R. 17 mm.); adult unknown. Type, *Gastraster margaritaceus*, Perrier [Perrier.
Gastraster,
- c*³. Actinal plates in two or more prominent series forming the actinal or the actinal and actinolateral surfaces of ray (and not dominated or overhung by the inferomarginals).
- d*¹. Large unguiculate straight pedicellariæ; actinostome sunken, the adoral carina long, consisting of more than three pairs of contiguous postoral adambulacral plates. Type, *Asterias sulcifera*, Perrier = *A. lurida*, Philippi [Sladen †.
Cosmasterias,
- d*². No large unguiculate pedicellariæ; actinostome not sunken; adoral carina short, consisting of one or two pairs of contiguous postoral adambulacral plates.
- e*¹. Plates small, with numerous small granuliform spinelets; abactinal skeleton close-knit, with small papular areas in the equivalent of four to six dorsolateral series (though usually irregularly distributed); carinal plates regular; superomarginals small and with numerous small granuliform

* This genus, which includes *Calycaster*, Perrier, founded upon a very immature form, is so different from the general run of Asteriidæ that it deserves segregation in a separate subfamily, Neomorphasterinæ, nov. It differs from the Zoroasteridæ in possessing crossed pedicellariæ and in lacking dimorphic adambulacral plates.

† *Quadraster*, Perrier, 1896, type *Stichaster felipes*, Sladen, belongs here. Perrier compared his genus with *Stichaster*.

- spinelets; equivalent of two or three longiseries of actinal plates; adambulacral plates proximally diplacanthid and triplacanthid. Type, *Stichaster roseus* (Müller), Sars [Verrill, *Stichastrella*,
- e*². Plates large, with coarse, often capitate, globose spines and tubercles; abactinal skeleton with large more or less irregular meshes in two dorsolateral series on either side of the irregular carinal series; superomarginals with one to several capitate stout spines; inferomarginals with one to three spines; one to three series of actinal plates, usually two or three; one well-defined though sometimes irregular series of dorsolateral plates; adambulacrals very regularly diplacanthid. Type, *Uniophora globifera*, Gray = *Asterias granifera*, Lam. *Uniophora*, Gray *
- b*². Adambulacral plates monacanthid.
- c*¹. Dorsolateral plates numerous, three- or four-lobed, in three irregular series; superomarginals not conspicuously broader than the actinals; inferomarginal plates monacanthid and diplacanthid, not forming a sharp ventrolateral edge to ray; rays long, rather slender; crossed pedicellariæ scattered; no actinal plates. (For further details see under section 4.) Type, *Hydrasterias verrilli*, Fisher, Hawaiian Islands [gen. nov. *Tarsastrocles*,
- c*². Dorsolaterals not very numerous, trilobed, in one or two fairly regular series, more or less concealed by integument; superomarginals very broad; inferomarginals (each bearing an oblique comb of two to four prominent spines) form a sharp ventrolateral border to ray; an inconspicuous series of actinal plates; rays short and thick; gonads open ventrally. (See also under section 4.) Includes *Stichorella*, Koehler †. Type, *C. asterinoides*, Perrier. [Perrier, *Calvasterias*,
- a*². Adambulacral spines carry pedicellariæ singly or in clusters; one or two series of actinal plates.

* *Uniophora globifera*, Gray, is apparently the same species as the earlier *Asterias granifera*, Lamarck, as I have examined a cotype of *globifera* and photographs of the type, as well as photographs of the types of *Asterias granifera*, Lamarck, *A. fungifera*, Perrier, and *A. sinuoida*, Perrier. The last two species apparently belong to *Uniophora*. I do not know what Gray's *Margaraster* is. At first sight it appears to be a synonym of *Uniophora*, but is described as having monacanthid adambulacrals. If it is anything more than a "book" genus, it would appear to be a synonym of *Pisaster*.

† See Fisher, Ann. & Mag. Nat. Hist., Dec. 1922, p. 597.

- b*¹. Ambulacral pores not unusually large; gonads opening ventrally; adambulacrals diplacanthid or mixed diplacanthid and monacanthid. *Leptasterias camchatica* (Br.), *vancouveri* (Perrier), *æqualis* (Stimp.), *hexactis* (Stimp.), and others have abactinal plates in more or less evident longiseries. See section 4, *a*¹, *b*¹, *c*² [Verrill.
Leptasterias,
- b*². Ambulacral pores unusually large (quadri-serial); abactinal and marginal plates broad, lobed, closely imbricated, with very small papular areas; dorsolateral plates in three series proximally; plates closely covered with clusters of minute spinelets; two series of actinals proximally; adambulacrals mostly diplacanthid; gonads unknown, Type six-rayed. Type, *Leptasterias macropora*, Verrill. [Verrill.
Stenasterias,
4. Abactinal skeleton an irregular net with meshes of various sizes, the plates being sometimes closely but irregularly imbricated by their lobes; abactinal plates not in rather obvious longitudinal series (but occasionally in more or less evident transverse series); carinal series usually but not always distinguishable, and frequently very irregular.
- a*¹. Adambulacral spines provided with clusters of straight or of straight and crossed pedicellariæ, or, exceptionally, with only single pedicellariæ (see note under *Leptasterias*).
- b*¹. Adambulacrals diplacanthid, or mixed diplacanthid and triplacanthid, or mixed diplacanthid and monacanthid.
- c*¹. Gonads opening dorsally; species never carry eggs and young (so far as known).
- d*¹. A single series of actinal plates, either spineless and more or less superficially invisible, or with a single small spine; a single series of actinal papular areas alternating with the actinal plates; furrow-spine of alternate adambulacral plates more or less advanced into furrow; inferomarginal plates strictly actinal in position, the superomarginals defining ambitus; crossed pedicellariæ not unusually large. Type, *A. rubens*, Linn. . . *Asterias*, Linn.*.

* Includes *Allasterias*, Verrill (type *A. rathbuni*, Verrill = *Asterias amurensis*, Lütken), and *Parasterias*, Verrill (type *P. albertensis*, Verrill). *Asterias rubens* is a typical *Allasterias*. *Asterias amurensis*, the type of *Allasterias*, is only slightly different from *rubens*, the type of *Asterias*, s. s. *Parasterias*, the type-specimen of which I have examined, has the adambulacral armature and other features as in *Asterias*. Professor Verrill overlooked the furrow-spine of the alternate adambulacral plates of *Parasterias*. The armature is alternately triplacanthid and diplacanthid at the base of the ray and diplacanthid distally. The furrow-spine of alternate plates is more advanced into the furrow, as in typical

- d*². Actinal plates in three to five prominent series (each plate bearing one or two stout spines), separated by series of papular areas; furrow-spine of alternate adambulacral plates often somewhat advanced into furrow; inferomarginals usually not actinal but lateral in position; crossed pedicellariæ not unusually large. Type, *A. troschelii*, Stimpson [Verrill*,
Evasterias,
- d*³. No actinal plates; with unusually large, slender-jawed, crossed pedicellariæ; abactinal skeleton weak; marginal plates strong, with one prominent superomarginal and one still longer inferomarginal spine; adambulacral plates mostly diplacanthid, with sometimes numerous straight pedicellariæ along furrow-margin; some of these occasionally attached to base of furrow-spines, but not usually. Type, *Asteracanthion linckii*, M. & T. *Urasterias*, Verrill.
- c*². Gonads opening ventrally; many species known to carry eggs and young; abactinal skeleton more or less open, the dorsolateral plates usually irregular, but spines sometimes in poorly defined longiseries; spines usually small, normally with a small or fairly thick collar of pedicellariæ; crossed pedicellariæ without enlarged teeth on the moderately broad terminal lip; one, or in large species two, series of actinal plates; adambulacrals diplacanthid or mixed diplacanthid and monacanthid; adambulacral pedicellariæ normally in clusters on the spines, but occurring singly and even very sparingly in individuals which have very few pedicellariæ elsewhere on body. Type, *Asteracanthion mülleri*, Sars [Verrill†,
Leptasterias,

Asterias, while the abactinal, marginal, and actinal plates are essentially as in *rubens* and close allies. The actinal plates of the ray are very small. For six-rayed "*Asterias*" see *Leptasterias*.

* Large specimens of *Leptasterias* may lead to this section; but in *Leptasterias* the gonads open ventrally and the actinal area is narrow, with not more than two series of plates; rays 6.

† This genus includes *Ctenasterias*, Verrill (type *A. cribraria*, Stimpson = *A. groenlandica*, Sars). Some of the other species are:—*Leptasterias polaris* (M. & T.) [= *Asterias acervata borealis* (Perrier), Verrill]; *L. polaris acervata* (Stimpson); *L. polaris katherinæ* (Gray); *L. camtschatica* (Brandt) [= *Asterias multiclava*, Verrill]; *L. merriami* (Verrill, as *Orthasterias*); *L. arctica* (Murdoch); *L. alaskensis*, Verrill [or *L. epichlora* (Brandt), Verrill], with numerous subspecies; *L. hexactis* and *L. æqualis*, Stimpson. These are mostly North Pacific-Bering Sea species. *L. macouni*, Verrill, the type of which I have examined, seems to be a small six-rayed *Evasterias troschelii*; *L. obtecta*, Verrill, is apparently an individual variant of *L. groenlandica*. The inclusion of the *polaris-acervata-katherinæ* group in this genus is on the basis of the structure of the gonad,

- b*². Adambulacral plates monacanthid; with actinal plates in one inconspicuous series or lacking, and gonads opening ventrally (pædophoric); size small; pedicellariæ on adambulacral spines rather few and inconspicuous. (Formæ of several species.) [Verrill.
Leptasterias,
- a*². Adambulacral spines devoid of attached pedicellariæ, although large and small straight pedicellariæ may occur on the surface of the plates or on fleshy peduncles attached to plates near base of spines; clusters of the latter in dried specimens occasionally appear to spring from the spine-sheath, but in reality do not.
- b*¹. Adambulacral plates diplacanthid, at least at base of ray; rarely triplacanthid.
- c*¹. Crossed pedicellariæ unusually large, the jaws narrow and rather definitely hooked terminally; dorsolateral skeleton a very delicate and irregular meshwork, which may degenerate into more or less disconnected plates; marginal plates conspicuously larger than dorsolateral; carinal and dorsolateral spines acicular, isolated, without wreaths of pedicellariæ (except a few distal carinals in some old specimens).
- d*¹. Crossed pedicellariæ very large and of unusual form, with slender serrate jaws terminating in an unexpanded unguiculate tip; marginal spines prominent, acicular, one to a plate, the inferomarginals with a very large cluster or cushion and the superomarginals with a wreath of crossed pedicellariæ; very numerous, large, compressed-ovoid, straight pedicellariæ; gonads opening just above superomarginal plates in interbrachial angle. Type, *Asteracanthion linckii*, M. & T. *Urasterias*, Verrill.

which opens ventrally, and on that of the skeleton, which differs from the skeleton of typical *Asterias*, particularly as regards the marginal and actinal plates, and the adambulacral armature. Since *polaris* was described as an *Asteracanthion*, and is a *Leptasterias*, it does not compete with the prior *Asterias polaris*, Sabine, 1824. The substitution of *acervata* in the binomial combination, as adopted by Verrill (entirely justified on his premises), is therefore not necessary.

The clusters of pedicellariæ (both crossed and straight, or either in predominance, or either alone) are a characteristic feature of *Asterias*, s. s., *Evasterias*, *Leptasterias*, and *Stenasterias*. Certain individuals of *Leptasterias* (e. g., in *L. littoralis*), which vary in the direction of few pedicellariæ, may almost or quite lack pedicellariæ on the adambulacral spines (or in dried specimens lose the few they may have had). The character is fundamental, and the exceptions are individual or varietal rather than specific. *L. groenlandica* of the Arctic Atlantic region usually lacks these pedicellariæ; Bering Sea specimens have abundant adambulacral spine pedicellariæ.

- d*². Crossed pedicellariæ smaller, with relatively stouter jaws, scattered thickly over the abactinal and lateral surfaces, *but not in wreaths or clusters* on the abactinal or marginal spines; superomarginals monacanthid; inferomarginals diplacanthid, or mixed monacanthid and diplacanthid distally; gonads opening just above superomarginal plates a short distance from base of ray. Type, *Asterias panopla*, Stuxberg *Icasterias*, gen. nov.
- c*². Crossed pedicellariæ not unusually large, but small, with blunt, terminally spatulate, denticulate jaws—the conventional type.
- d*¹. Abactinal plates and spinelets well developed.
- e*¹. Both series of marginal plates normally developed, easily distinguishable.
- f*¹. No actinal plates*; dorsolateral plates numerous, irregular, with small spinelets, and showing sometimes a tendency to form transverse series (usually, however, not well marked); inferomarginal spines two to four in a transverse series, the consecutive combs closely placed.
- g*¹. Inferomarginal spines bearing crossed pedicellariæ; abactinal spinelets surrounded by a circlet of crossed pedicellariæ.
- h*¹. Papulæ compound, each subdivided terminally into upward of eight small papillæ; inferomarginals diplacanthid, superomarginals monacanthid; adambulacrals diplacanthid; not fissiparous; gonads opening just above superomarginals abactinally in interbrachial angle; large unguiculate straight pedicellariæ. Type, *Aphanasterias pycnopodia*, sp. n.† [gen. nov.
Aphanasterias,

* *Smilasterias scalprifera* has a very inconspicuous series of actinals, while *S. triremis* lacks them. The other three genera, so far as known, have no vestige of actinals.

† *Aphanasterias pycnopodia*, gen. et sp. n. Rays 5. Resembling a 5-rayed large *Stephanasterias* in general habit, but differing as detailed above. $R=76$ mm.; $r=7$ mm., $R=10.8r$; breadth of ray at base 9 or 10 mm.; disk very small, rays slender, tapering; marginal plates on ventrolateral margin; tube-feet very crowded, sometimes five or six across the furrow; actinostome small, sunken; adoral carina well developed; abactinal spinelets conical, one to a plate, 0.5 to 0.6 mm. long, not close; carinals in regular series; superomarginal spinelets forming one, inferomarginals two, and adambulacrals two regular longiseries; large unguiculate straight pedicellariæ; crossed pedicellariæ in small circles around

- h*². Papulæ simple, undivided; inferomarginals with three or four spinelets in a transverse comb; superomarginals with several spinelets in a comb; adambulacrals triplacanthid, at least in part; strongly fissiparous, rays upward of eight; gonads opening between supero- and inferomarginal plates, low on side of ray, in the axillary channel; large bivalved, dentate, straight pedicellariæ. Type, *Asteracanthion albulus*, Stimpson [Verrill. *Stephanasterias*,
- h*³. Papulæ simple, rays 5, not fissiparous; gonads opening just above superomarginals at a distance from interbrachial angle; adambulacrals diplacanthid; inferomarginals and superomarginals with transverse comb of three or four spines each; straight pedicellariæ small, compressed, lanceolate. Type, *Asterias japonica*, Bell [gen. nov. *Aphelasterias*,
- g*². Inferomarginal spines chisel-shaped, entirely without pedicellariæ; abactinal crossed pedicellariæ isolated, not in circlets around the spinelets. Type, *A. scalprifera*, Sladen [Sladen. *Smilasterias*,
- f*². Actinal plates in one to three series; not fissiparous; eggs and young not brooded by adult.
- g*¹. Plates small, with numerous small granuliform spinelets; abactinal skeleton close-knit, with small papular areas in the equivalent of four to six dorsolateral series (usually irregularly distributed); carinal plates regular; superomarginals small and with numerous small granuliform spinelets; equivalent of two or three series of actinal plates; adambulacral plates proximally diplacanthid and triplacanthid. Type, *Asterias rosea*, Müller (*Stichaster*, auct.) [Verrill. *Stichastrella*,
- g*². Plates large, with few coarse

the abactinal and superomarginal spinelets, and in tufts on the inferomarginals; papulæ giving the abactinal and intermarginal areas a papillose appearance. 48 fathoms, off Shumagin Islands, Alaska.

(often very large), capitate, globose spines and tubercles; abactinal skeleton with large, more or less irregular meshes, in two dorsolateral series on either side of the irregular carinal series; superomarginals with 1 to 3 spines; 1 to 3 series of actinal plates—usually 2 or 3; 1 well-defined though sometimes irregular series of dorsolateral plates; adambulacrals very regularly diplacanthid. Type, *U. globifera*, Gray = *A. granifera*, Lam. (see sect. 3, a^1 , b^1 , c^3 , d^2 , e^2 , and footnote)

Uniophora, Gray.

f^3 . Actinal plates in one or two series; not fissiparous; gonads opening ventrally; young brooded by adult; marginal plates clearly distinguishable, very regular, marked by differentiated spines; abactinal spines mostly isolated, irregular, surrounded by a collar of crossed pedicellariæ; superomarginals usually monacanthid, inferomarginals monacanthid or diplacanthid; actinals monacanthid; adambulacrals regularly diplacanthid; three or four pairs of contiguous postoral adambulacral plates. Type, *Diplasterias lütkeni*, Perrier = *Asterias brandti*, Bell

[Perrier.
Podasterias,

e^2 . Either the superomarginal plates or those of both series not easily distinguishable.

f^1 . Only the inferomarginals of the two series clearly distinguishable; to them are joined small lateral transverse arcs (containing the superomarginals), separated consecutively by broad papular areas or skeletal spaces; abactinal skeleton an irregular network of plates, without indication of a carinal series; abactinal and inferomarginal spinelets slender, cylindrical, in small groups; two long adambulacral spines; ambulacral furrows wide, with large four-ranked tube-feet; rays 9 or 10, fissiparous. Type, *S. brachiata*, Koehler

[Koehler.
Saliasterias,

f^2 . Marginal plates not superficially distinguishable; a close granulation more or less uniform, without serial arrangement, interspersed with scattered pedicellariæ, overlies

- relatively large 3- to 5-lobed plates in an irregular abactinal reticulum; marginals 4-lobed; an incomplete series of actinals; size small; gonads opening ventrally. (Includes *Hemiasterias*, Verrill, type *G. biseriatus*, Koehler.) Type, *Stichaster nutrix*, Studer *Granaster*, Perrier.
- d*². Abactinal skeleton weak or else abortive; abactinal integument thick, papillose; no actinal plates.
- e*¹. Marginal and actinal plates present; marginal plates well developed; the superomarginals with one spine wreathed with pedicellariæ and having long descending processes which form a broad, vertical, intermarginal channel; inferomarginals with two webbed spines (each with a cluster of pedicellariæ on outer face); abactinal surface soft, rather irregularly and finely papillose; abactinal plates thin (with rudimentary spinelets only), forming an irregular reticulum entirely concealed by the skin; interbrachial septum strongly calcified; gonads opening ventrally, eggs huge; good-sized, broadly lanceolate, straight pedicellariæ on furrow-margin; two pairs of postoral adambulacral plates contiguous; adambulacral plates regularly diplacanthid. Type, *Diplasterias turqueti*, Koehler [Verrill, *Cryptasterias*
- e*². Neither marginal nor abactinal plates present, the skeleton reduced to the ambulacral and adambulacral systems (see sect. 5) [Verrill, *Adelasterias*,
- b*². Adambulacral plates monacanthid.
- c*¹. Actinal (ventrolateral) area broad, with two to four long series of conspicuous spiny actinal plates; actinostome very sunken; adoral carina narrow and long; gonads opening dorsally; carinal plates evident; dorsolateral skeleton robust, irregular, with stout spines; in addition to large unguiculate straight pedicellariæ, a peculiar small straight variety, having on each jaw a short, sharp and a long, truncate, laminate prong; among the adambulacral spines are clusters of straight pedicellariæ on long peduncles arising from the plates. Type, *Asterias ochracea*, Brandt *Pisaster*, M. & T.
- c*². Actinal area not prominent; actinal plates in one series or wanting; no peculiar straight pedicellariæ with bifid jaws, as in

- c*¹; abactinal skeleton more or less well developed, consisting of lobed and oblong plates united into rather close meshwork, the carinal series being distinguishable; adoral carina composed of three to five pairs of united adambulacral plates.
- d*¹. Integument not thick nor covered with compound "cauliflower" pustules enclosing spines and completely hiding the skeleton.
- e*¹. Dorsolaterals numerous, forming an irregular network, in which not very regular longitudinal series can sometimes be distinguished; superomarginals not relatively very broad; inferomarginal plates and spines not forming a sharp ventrolateral border to ray.
- f*¹. Crossed pedicellariæ in circlets surrounding the abactinal and marginal spines; gonads opening ventrally; a series of actinal plates, usually spiniferous (absent in young specimens). (Including *Parastichaster*, Koehler*.) Type, *Asterias rugispina*, Stimpson [Perrier.
Sporasterias,
- f*². Crossed pedicellariæ scattered, not in circlets around spines; gonads opening dorsally. Plates robust; marginals and carinals four-lobed; dorsolaterals both three- and four-lobed, in three series; papular areas small, in about three dorsolateral and one intermarginal series on each side; no actinal papulae; spines short, cylindrical, blunt, mostly one to a plate; inferomarginal spines large, usually two to a plate (often only one); adoral carina composed of five pairs of contiguous adambulacrals; actinostome small and sunken; a few fairly large, spatulate, denticulate, straight pedicellariæ. Type, *Hydrasterias verrilli*, Fisher [gen. nov.
Tarsastrocles,
- e*². Dorsolateral plates three-lobed, in one or two subregular series, more or less concealed by integument; superomarginals very broad; inferomarginals each bearing an oblique comb of two to four prominent spines, form a sharp ventrolateral border to ray; an inconspicuous series of actinal plates;

* See Fisher, Ann. & Mag. Nat. Hist., Dec. 1922, p. 596.

- gonads open ventrally. Type, *C. asterinoides*, Perrier [Perrier*.
Calvasterias,
- d*². The thick dermis is raised into conspicuous "cauliflower" pustules which enclose spines and entirely obscure the skeleton; abactinal skeleton an irregular but complete reticulum of small imbricated, mostly simple elliptical to oblong, occasionally faintly lobed plates; carinal series very irregular; superomarginals monacanthid; inferomarginals mostly diplacanthid; the spines surrounded by mammilated sheaths which contain (like those of dorsal surface) a few fair-sized crossed pedicellariæ without enlarged terminal teeth; proximal adambulacrals occasionally diplacanthid; numerous scattered, narrowly spatulate to compressed, broadly lanceolate, often pedunculate straight pedicellariæ; tube-feet crowded, large, quadriserial; gonads open ventrally, although attached on level with marginal plates; adoral carina composed of four pairs of contiguous adambulacrals plates. Type, [Fisher †.
Anasterias octoradiata, Koehler *Koehleraster*,
- c*³. Marginal and abactinal skeleton much reduced, consisting of lateral, spaced, transverse tongues of plates (composed of two reduced marginals, with sometimes one or several abactinals) joined to the adambulacrals; dorsal surface with much reduced, disconnected, scattered abactinal plates. See section 5 for further details *Lysasterias*, Fisher.
5. Abactinal surface devoid of a connected skeleton, soft and flexible, the abactinal plates, if present, isolated, spaced, and generally superficially invisible.
- a*¹. Both series of marginal plates present; adambulacrals plates monacanthid.
- b*¹. Rays upward of 24, always more than 6, even in young; plates of both marginal series imbricating directly; alternate superomarginals spineless; inferomarginals diplacanthid, each spine with a sheath and bouquet of pedicellariæ; abactinal spines surrounded by a cushion of crossed pedicellariæ and attached to isolated subcircular plates; lateral,

* Includes *Stichorella*, Koehler, type *Stichaster suteri*, de Loriol. The known species are:—*C. asterinoides*, Perrier, *C. laevigata* (Hutton) = *Stichaster suteri*, var. *laevigatus*, Hutton, *C. suteri* (de Loriol), *C. stolidota*, Sladen, *C. antipodum*, Bell. See *antea*, sect. 3.

† Ann. & Mag. Nat. Hist., Dec. 1922, p. 593.

oblique, transverse bands of small plates widely spaced on proximal part of ray; adambulacral plates with pedunculate bouquets of pedicellariæ; gonads opening abactinally.

Type, *Asterias helianthoides*, Brandt

[Stimpson.
Pycnopodia,

b². Rays 5; beyond base of ray, at least, plates of both marginal series not joined directly in series, but sometimes by a line of vestigial plates, in the case of the superomarginals.

c¹. Abactinal and marginal spines with a conspicuous tough sheath expanded at summit and bearing numerous small crossed pedicellariæ (of which each jaw has a conspicuously enlarged terminal tooth on one side and very numerous shank-teeth); superomarginals rather well spaced (alternates spineless), but connected by a line of vestigial plates; inferomarginals diplacanthid, the two spines immersed in a single tough sheath, widely expanded terminally; abactinal integument thin; plates widely spaced, interspersed with numerous vestigial microscopic platelets; adambulacral plates with isolated pedicellariæ; mouth-plates broad, with only one pair of contiguous, enlarged, postoral adambulacral plates; gonads opening abactinally.

Type, *L. anthosticta*, Fisher

[Fisher*.
Lysastrostoma,

c². Marginal and abactinal skeleton much reduced, consisting of lateral, spaced, transverse series or tongues of plates (composed of two reduced marginals plus sometimes one or several abactinals) abutting on the adambulacral plates; dorsal surface with much reduced, disconnected, scattered platelets; dermis thick, surrounding the spinelets in mammillated pustules; gonads opening ventrally. (Includes *Anasterias*, auct., nec Perrier; *Asteroderma*, Perrier; *Pedasterias*, Verrill.) Type, *Anasterias perrieri*, Studer

[Fisher†.
Lysasterias,

a². Neither marginal nor abactinal plates present, the skeleton reduced to the ambulacral and adambulacral systems; body covered with numerous papillæ, containing each a slender spinelet, disposed without order on all surfaces; adambulacrals diplacanthid. Type, *Diplasterias papillosa*, Koehler

[Verrill.
Adelasterias,

Pacific Grove, California.

* Ann. & Mag. Nat. Hist., Dec. 1922, p. 590.

† *Ibid.* p. 592.